Second, we investigate the evolution of such a system and we discuss the implications for fragmentation: the origin and structure of dense cores of a few solar masses. We show that, for steep enough power spectrum of the supersonic turbulence which supports the clouds, a range of small scales may be gravitationally unstable when others are still stable: larger scales being supported by turbulence, smaller scales being thermally supported.

REFERENCES

Falgarone, E., Puget, J.L.: 1985, Astron. Astrophys. 142, 157.
Falgarone, E., Puget, J.L.: 1986, Astron. Astrophys. in press.
Pérault, M., Falgarone, E., Puget, J.L.: 1985, Astron. Astrophys. 152, 371.
Pérault, M., Falgarone, E., Puget, J.L.: 1986, Astron. Astrophys. in press.

STAR FORMATION INDUCED BY SUPERSONIC TURBULENCE

Makoto Tosa, Yutaka Sabano
Astronomical Institute, Tohoku University, Sendai, Japan

Supersonic turbulent motion of gas plays a significant role in the dynamics and physics of a cosmic gas cloud. One of the most important effects of the supersonic turbulence is a strong compression of the gas by shock waves, that may trigger the gravitational instability of the shock-compressed layer leading to the formation of stars.

We studied fragmentation processes in the interstellar molecular cloud and the protogalactic gas cloud, which are dominated by supersonic turbulence, with special emphasis in the stability of the compressed layer formed by receding shock waves as a result of a collision of the turbulent gas elements.

The interaction of the turbulent gas elements is simply modeled by a head-on collision of a pair of supersonic gas flows. Since the compression of the gas parallel to the direction of the gas flow dominates, the gas dynamics is essentially one dimensional. The propagation of the shock waves and the evolution of the shock-compressed layer are followed by a one-dimensional gas dynamical simulation until the self-gravity becomes significant.

Because of the one-dimensional nature of the shock compression, if the compressed layer becomes gravitationally unstable, a gravitational instability is expected for a perturbation normal to the collision axis. The stability of the shock-compressed layer is examined for the parameters obtained by the numerical simulation.

https://doi.org/10.1017/S0074180900096200 Published online by Cambridge University Press

In the molecular clouds, the efficient cooling by CO molecules and its sensitive dependence on the gas density make the shock-compressed layer so cold and dense that the layer becomes gravitationally unstable and breaks into fragments, even if the gas elements are gravitationally stable prior to the collision. The mass of the unstable fragments is estimated to be about two solar masses or less, irrespective of the presence of the magnetic field (Sabano and Tosa 1985).

During the formation of a galaxy, it is expected that after an initial contraction of a protogalaxy, it settles down in a dynamical equilibrium, the virial equilibrium, state in which the gravitation is balanced by the internal motion of the gas. The virial velocity of the protogalactic gas cloud is supersonic, so the formation of a shock compressed layer due to a collision of gas elements is expected as in the interstellar molecular cloud.

The supersonic motion of the gas in the cloud causes the density enhancement of the gas by shock waves; thus a protogalactic gas cloud is modeled as an ensemble of gas clumps moving with supersonic velocity.

We made similar calculations as in the interstellar molecular cloud for the supersonic collision of gas clumps in a protogalactic gas cloud and examined the stability of the shock-compressed layer for different abundances of the heavy elements.

Since the cooling is very efficient in the shock-compressed layer, the layer becomes so cold and dense that it becomes gravitationally unstable and breaks into fragments even if the gas clumps are gravitationally stable prior to the collision. For typical parameters expected in a protogalactic gas cloud, the mass range of the fragments which becomes gravitationally unstable after a collision is estimated to be 10^5 - 10^7 $M_\odot$, which just coincides with that of globular clusters.

REFERENCE

Sabano, Y., and Tosa, M.: 1985, Astrophys. Space Sci. 115, 85.